3. Mind Map: Equations of Motion

Equations of Motion

- **Basic Equations**
  - $v = v_0 + at$
  - $x - x_0 = v_0t + (1/2)at^2$
- **Additional Equations**
  - $v^2 = v_0^2 + 2a(x - x_0)$
  - $x - x_0 = (1/2)(v_0 + v)t$
  - $x - x_0 = vt - (1/2)at^2$
  - $S_n = v_0 + (a / 2)(2n - 1)$

For motion in a straight line: vertical (gravity), horizontal or at an angle

v_0 = initial velocity
v = final velocity
x_0 = initial position
x = final position
a = acceleration
t = time of travel
S_n = displacement in nth second

- **Motion under gravity**
  - (1) Acts as constant acceleration: 9.8 m/s^2 downward (2) Always taken as negative (-9.8 m/s^2) in equations, indicating downward direction. (3) Hence a vector *(assuming a sign convention that takes downward as -ve)*
  - Velocity increases by 9.8 m/s every second under free fall.
  - **Equations**
    - Maximum height: $H = v_0^2 / (2g)$
    - Time for max. height
      - $t = v_0 / g$
      - $t = \sqrt{(2H / g)}$
    - Height after t sec. fall: $h' = H - (1/2)gt^2$
    - Distance fallen: $h = 1/2gt^2$
    - Ratio of distances, successive sec.: $1^2 : 2^2 : 3^2 ...$
    - Displacement in nth sec: $h_n = (g / 2)(2n - 1)$
    - Velocity on return: $-v_0$
    - Velocity just before ground impact: $v = \sqrt{2gH}$

1. *Use ground level as reference (y = 0)*
2. *Ensure correct sign conventions for direction*
3. *Acceleration due to gravity is active when the object reaches top of the flight*

1. *Sketch motion diagrams, indicating initial and final positions, velocities, and accelerations to better understand the problem.*
2. *Solve Algebraically Before Substituting Values: Manipulate equations symbolically to isolate the desired variable before plugging in numerical values.*